Discussion of the distributional and morphological differences between these two varieties and further specimen citations may be found in Brittonia 25: 83-85. 1973.—*Paul A. Fryxell, Agronomy Field Laboratory, Texas A&M University, College Station, Texas 77843.*

SEED GERMINATION AND SEEDLINGS OF KRAMERIA LANCEOLATA (KRAMERIACEAE)—*Krameria lanceolata* Torr. (=*K. spathulata* Small), sandspur, a suffrutescent low-growing perennial, has thin, wiry rhizomes and large, fleshy storage roots. The small, lanceolate, canescent leaves are deciduous.

Parasitism was first reported in the genus *Krameria* in 1910 (Cannon 1910), but the parasitic behavior of *K. lanceolata* was not recorded until recently (Musselman 1976). Like many species of Scrophulariaceae, Olacaceae, and Santalaceae, *Krameria lanceolata* is a hemiparasite, forming haustoria on roots of neighboring plants. It likewise has a broad host range, attaching to trees, shrubs, grasses, and other plants.

Krameria lanceolata occurs from Kansas south to Arizona, Texas, Chihuahua, and Coahuila, Mexico with disjunct populations in Florida and Georgia. In Georgia it occurs on sandy ridges along coastal rivers, and in Florida it is found mostly on deep sands in several northern and central countries. The largest populations we found were near Tampa, Florida.

Very little is known about the life history of these plants. In a review of previous work on this genus Kuijt (1969) states: "We know virtually nothing about the process of germination" and, further, "the entire process of germination . . . is unexplained." Our note records, apparently for the first time, information on germination and seedling development. Observations were made during a cooperative study between Old Dominion University and the Southern Forest Experiment Station of the U. S. Forest Service to survey all root parasites in the Southeast relative to their potential as pathogens of commercial tree species.

METHODS AND MATERIALS

Fruits were collected in June 1976 at the ecology study area of the University of South Florida in Tampa and immediately sent to the Forest Service laboratory, Pineville, Louisiana, where they were planted with approximately 20 commercial tree species. Voucher specimens are deposited in the herbarium of Old Dominion University (ODU) and the herbarium of the University of South Florida (USF). Twenty surplus fruits were soaked in water for 48 hours and the seeds were excised. Eleven seeds enlarged due to imbibition of water; nine remained the same size. The 11 enlarged seeds were placed on moist fiber in a germination room maintained at 24° C with 16 hours of light and 8 hours of dark. Only five seeds germinated; they were planted in pots with *Pinus taeda* seedings.

OBSERVATIONS AND DISCUSSION

The ovary of *K. lanceolata* contains two ovules, one of which always aborts. We found nothing resembling the situation in *K. grayi* reported by Kuijt (1969) where apparently mature fruits did not contain well-developed seeds. We estimate that as many as 70% of the fruits had fully developed seeds in them. The morphology of the seed is similar to that illustrated by Kuijt as a fruit [sic] of *K. parviflora* var. *glandulosa* (Kuijt 1969: 156). The fleshy cotyledons contain an unusually large amount of starch. A thin testa covers the seed. None of the seeds planted in pots with potential hosts germinated. We attribute this to the low temperature (24° C) at which pots were maintained and to the soil used in the pots. Therefore, the information we present on germination is based on seeds removed from the fruits. However, this form of germination appears to be identical to that observed in the few fruits that dehisced and germinated in petri dishes. Germination in petri dishes was epigeal, in contrast to the suggestion of Kuijt (1969).

After 3 days on moist fiber, the radicle began to elongate and exhibited positive geotropism. At this stage, the seedling had a well-developed root cap but no root hairs. Secondary growth began about a week after germination with a resultant sloughing of cortical cells on the oldest part of the primary root. Secondary roots developed within 2 weeks of germination. While only a few seedlings were available for study, no haustorial attachments were noted in those seedlings that had been with their host plant for 10 days. Thus, it appears that the early stage of seedling development resembles many other root parasites in being autotrophic.

Germination and seedling development of *K. lanceolata* is similar to those of other root parasites such as those Scrophulariaceae, Santalaceae, and Olacaceae examined in our studies (Musselman and Mann, unpublished). Except for *Striga asiatica* (Scrophulariaceae), a germination stimulant is not necessary for germination or seedling development in these families. The one striking feature of the seedling of *K. lanceolata* is the apparent absence of root hairs.—*Lytton J. Musselman, Department of Biological Sciences, Old Dominion University, Norfolk VA 23508 and William F. Mann, Jr., U.S.D.A. Forest Service, Southern Forest Experiment Station, Pineville, LA 71360.*

REFERENCES

CANNON, W. A. 1910. The root habits and parasitism of *Krameria canescens* Gray. Carn. Inst. Wash. Publ. 129: 5-24.

KUIJT, J. 1969. The biology of parasitic flowering plants. Univ. Calif. Press, Berkeley.

MUSSELMAN, L. J. 1975. Parasitism and haustorial structure in *Krameria lanceolata* (Krameriaceae): A preliminary study. Phytomorphology. 25: 416-422 (pub. 1976).